# Geographic Information Systems in Education

Geographic information systems (GIS) provide a technology and method to analyze *spatial data*, or information about the Earth. The earth's climate, natural hazards, population, geology, vegetation, soils, land use, and other characteristics can be analyzed in a GIS using computerized maps, aerial photographs, satellite images, databases, and graphs. By analyzing phenomena about the Earth's hydrosphere, lithosphere, atmosphere, and biosphere, a GIS helps people understand patterns, linkages, and trends about our planet.
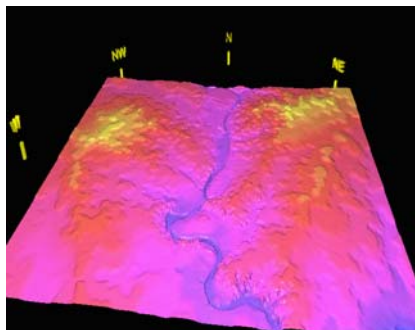
The USGS has been producing digital map data since the 1970s. These data sets include scanned topographic maps, digital aerial photographs, land use and land cover, hydrography, transportation, 3D models of the Earth's surface, satellite imagery, and more. The USGS makes extensive use of GIS to analyze urban growth, investigate the downstream effects of abandoned mine lands, to create flood models, and in other research.

Interest in Using GIS In Education

Since the 1960s, GIS has quietly transformed decision-making in universities, government, and industry by bringing digital spatial data sets and geographic analysis to desktop computers. *Geographic Information Sciences* include Geographic Information *Systems* as well as the disciplines of geography (examining the patterns of the Earth's people and physical environment), cartography (mapmaking), geodesy (the science of measuring and surveying the Earth), and remote sensing (studying the Earth from space).

GIS is used in three major ways in courses at the elementary, secondary, and university level. First, teaching *about* GIS dominates at the community college and university level, where courses in methods and theory of GIS are taught in geography, engineering, business, environmental studies, geology, and in other disciplines. Second, teaching *with* GIS is emphasized at the elementary and secondary level, where GIS is used to teach concepts and skills in earth science, geography, chemistry, biological science, history, and mathematics courses. Finally, GIS is used as an essential research tool in all institutes of higher education in geography, demography, geology, and other disciplines.

The U.S. Labor Secretary's Commission on Achieving Necessary Skills (SCANS) stated that the most effective way to teach skills is "in context" (U.S. Dept. of Labor 1991). SCANS competencies include identifying resources, working with others, using information, and understanding complex and changing inter relationships. Implementing GIS into the curriculum may encourage students to examine data from a variety of fields.

In 2004, the US Secretary of Labor named geotechnologies as one of the three fields most in demand for 21st Century decision-making. In 2005, the US Department of Labor began funding community college and other programs to improve the number and breadth of GIS courses and resources offered.

Since the publication of the first national content standards in geography (Geography Education Standards Project 1994), social studies (National Council for the Social Studies, National Task Force for Social Studies Standards 1994), science (National Research Council 1996), and technology (International Society for Technology in Education 2000), educators nationwide have been progressing toward a model of instruction that emphasizes a hands-on, interdisciplinary, research-based learning experience. The national geography standards state, "the power of a GIS is that it allows us to ask questions of data." Students using this inquiry approach form research questions, develop a methodology, gather and analyze data, and draw conclusions.

The National Academy of Sciences report *Learning to Think Spatially— GIS Across the Curriculum* (2006) emphasized the value of spatial thinking in geography and other disciplines, and needs to be cultivated throughout the curriculum.

The problems we face in the 21st Century—natural hazards, crime, terrorism, water availability and quality, biodiversity loss, climate change, urban sprawl, energy needs, and many more—are becoming more serious and are growing in geographic extent, affecting individuals' everyday lives. Each of these problems has a geographic component. Education in spatial analysis using GIS as the tool is the important skill that must be promoted if we hope to grapple with these issues.

The approach with GIS should not be, "How can we get GIS into the curriculum?" but "How can GIS help meet curricular goals?"

Examples of GIS In Education

Students using GIS in the curriculum are studying phenomena from the local to global scale. The use of GIS fosters a connection with the community through the acquisition of data and maps and through field work.

With GIS, students can examine the Earth in a new way, through three-dimensional analysis of a watershed, or by examining the Pacific "Ring of Fire" using a map projection that shows all of the Pacific Ocean in one view.

Vermont middle school students use GIS technology, science journals, and photographs to determine the origin and ecological relationship of a local pond to the community.

Idaho students use GIS to examine the history of mining and cemeteries in their community.

Rhode Island students study the economic impact of rivers in their communities. Other students map and analyze tree species on their school property.

In science courses, students use USGS earthquake information on the Internet in a lesson on plate tectonics (below).
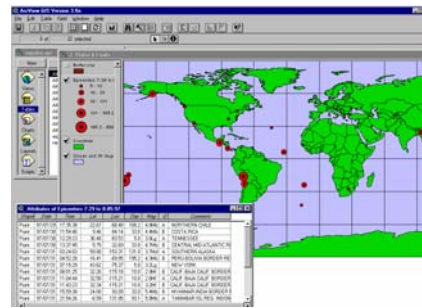
In North Dakota, high school students help state parks use GIS to study and manage their resources. Middle school students map alternative sites for a local landfill.

World Geography students examine the climate, vegetation, population, natural hazards, landforms, and political geography of Africa (below).
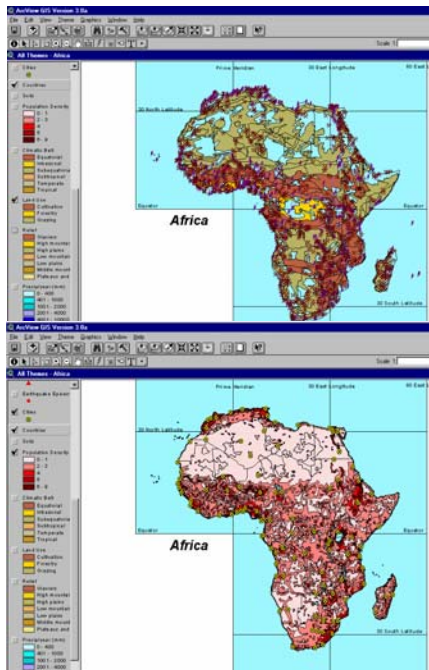
Students use GIS with Global Positioning System (GPS) receivers to collect coordinates and chemical constituents of local streams, such as pH, dissolved oxygen, and conductivity (below).

North Carolina students use GIS to study the history and development of the African American community in their city.

Students in Los Angeles map and analyze the ethnic makeup of neighborhoods over time.

Starting Points

GIS in Education:
education.usgs.gov

USGS online aerial photographs and topographic maps:
terraserver-usa.com

Educational Applications of GIS:
www.esri.com/k-12

National Atlas
nationalatlas.gov

Geography Network
www.geographynetwork.com

Software

ArcView, by Environmental Systems Research Institute (ESRI):
http://www.esri.com

Idrisi, by Clark Labs at Clark University:
http://www.clarklabs.org

GeoMedia, by Intergraph Corporation: www.intergraph.com

MapInfo, by MapInfo Corporation:
www.mapinfo.com

Maptitude, by Caliper Corporation:
www.caliper.com

Events

GIS Day:
www.gisday.com

ESRI hosts an international conference in GIS education each summer in California:
www.esri.com/educ

Listserv

TERC's EDGIS listserv, a discussion forum about the implementation of GIS in the curriculum:
list.terc.edu/mailman/listinfo/edgis

Books and Lessons

Mapping Our World: GIS Lessons for Educators and *Community Geography: GIS In Action,* both from ESRI Press

ArcLessons:
www.esri.com/arclessons

Training

USGS training for educators:
education.usgs.gov

List of Training Events:
kangis.org/learn

References

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International Society for Technology in Education. 2000. *National Education Technology Standards for Students.* Eugene, Oregon: ISTE, 373 p.

National Academy of Sciences. 2006. *Learning to Think Spatially— GIS as a Support System in the K-12 Curriculum.* Washington DC: The National Academies Press, 313 p.

National Council for the Social Studies. 1994. *Curriculum Standards for Social Studies.* Washington, DC: NCSS, 178 p.

National Research Council. 1996. *National Science Education Standards.* Washington, DC: National Academy Press, 262 p.

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